Thawing the Mystery of Extra Ice Crystals

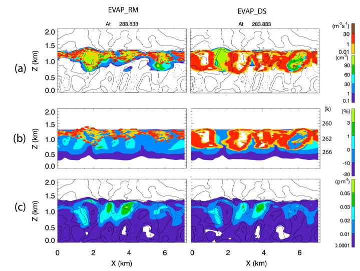
Research Highlight

Arctic mixed-phase clouds are complex because they consist of both ice and water. Although these clouds play an important role in Arctic climate change and the energy balance, they have not been understood well and are not well represented in current climate models. Understanding how mixed-phase clouds form and what affects their lifetime and properties will help scientists understand how they affect the overall climate.

To test ways that aerosols could form ice crystals, the researchers created an innovative combined model that shows more realistically the link between ice-forming aerosols and clouds. The team combined an existing dynamic framework with a size-resolved aerosol and cloud microphysics scheme that represents the physics of cloud formation, adding the two new ice-forming processes. The team also incorporated a radar simulator to evaluate how well the model predicted the number and size of ice crystals. In running the combined model, it used cloud data from a 2004 Atmospheric Radiation Measurement Program field study known as the Mixed-Phase Arctic Cloud Experiment (M-PACE).

The team concluded that other processes were helping form these extra ice crystals. In the first process, droplet evaporation residues condense and then freeze, forming ice crystals only near the top of the cloud. In the second process, droplets shrink during evaporation and then freeze through the inside-out contact freezing mechanism, forming ice crystals any place in the cloud.

The team found that computer simulations that included either of these processes increased the number of ice crystals by 10 to 15 times, similar to amounts found in actual cloud measurements.



The figure shows vertical cross sections of a mixed-phase cloud. In (a), the ice crystals form at different rates and locations in the liquid layer. Ice crystals in EVAP_RM form near the cloud top and ice crystals in EVAP_DS form anywhere in the cloud. Figure (b) shows the relationship between the formation of ice crystals and supersaturation (temperatures) in clouds in the two processes. In (c), there is little difference in ice water content between the two processes.

Reference(s)

Fan J, M Ovtchinnikov, JM Comstock, SA McFarlane, and A Khain. 2009. "Ice formation in arctic mixed-phase clouds: Insights from a 3-D cloud-resolving model with size-resolved aerosol and cloud microphysics." Journal of Geophysical Research, 114, D04205.

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Working Group(s)

Cloud Modeling